

Effect of Biodiesel on Pollutant Emissions

Bob McCormick
National Renewable Energy Laboratory

*Presented at
10th National Clean Cities Conference
May 3, 2004
Ft. Lauderdale*

303-275-4432
robert_mccormick@nrel.gov

Biodiesel Overview

- Produced from various vegetable oils, fats, waste cooking oil
 - Predominantly soybean oil in the U.S.
- US resource size roughly 2 billion annual gallon
- ~25 million gallon estimated in sales for 2003
- Can improve fuel lubricity
- Quality standard exists for B100 to be used as blend-stock
 - ASTM D6751
- B20 can be used to obtain fuel use credits under EPA Act



OEM Issues with Biodiesel

Engine and vehicle manufacturers have legitimate concerns:

- Quality specifications may not be adequate
- Lack of stability requirement in quality specifications
- Lack of a quality specification for biodiesel blends
- Need for long-term durability data
- Compatibility with 2007+ emission control systems

Nevertheless, a large number of users have experienced trouble free operation with biodiesel blends

Biodiesel Warranty Issues

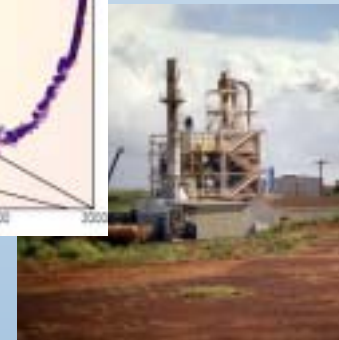
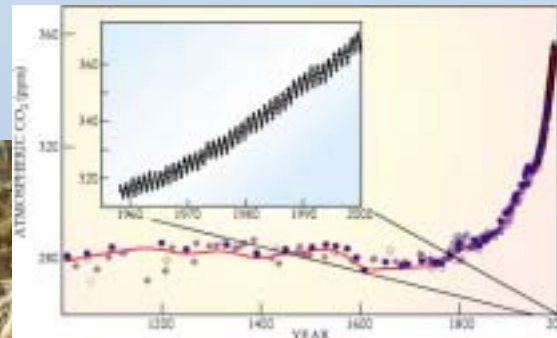
- Manufacturers warrant products against defects in materials and workmanship
- Use of biodiesel or biodiesel blends should have no effect on the materials and workmanship warranty
- Use of biodiesel does not “void the warranty”, this is prohibited by the Magnuson-Moss Warranty Act
- Failures caused by the fuel are not defects in materials and workmanship and therefore are not covered by warranty
- Manufacturers are legitimately concerned that use of biodiesel will result in increased numbers of warranty claims for what are not defects in materials and workmanship

Biodiesel Benefits: Energy Security and CO₂ Emissions

For Soybean-based biodiesel:

Life Cycle Energy Efficiency = 83% for petroleum diesel
= 81% for biodiesel

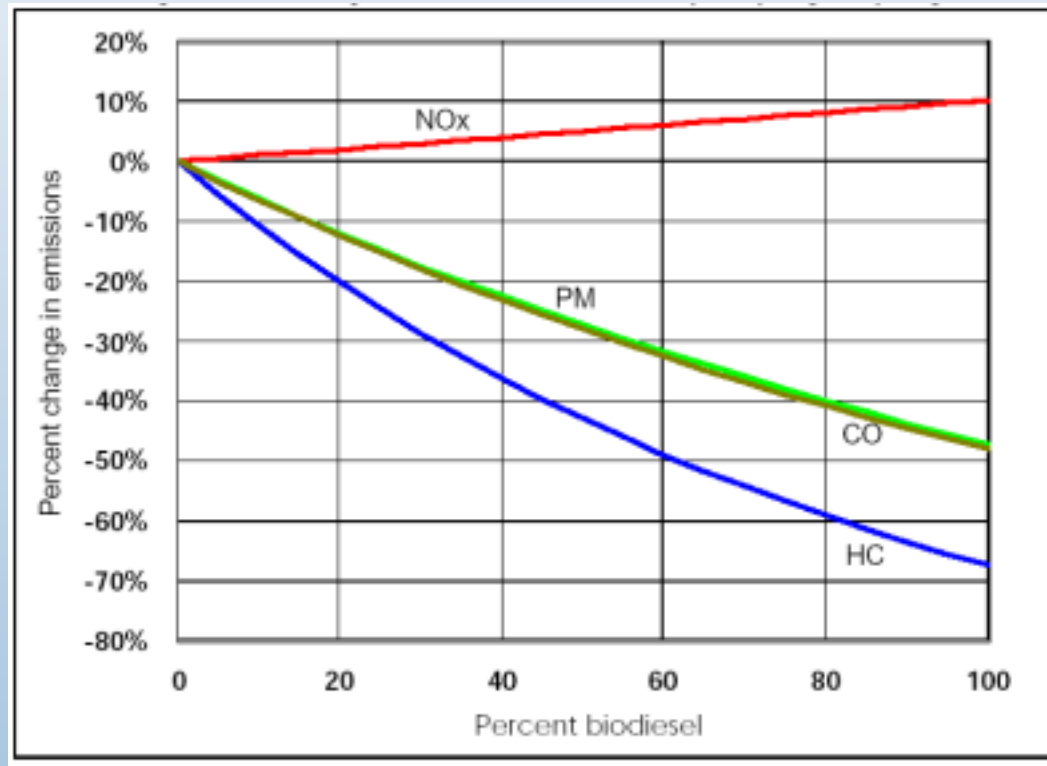
- Roughly the same amount of energy is required to produce refined petroleum diesel and biodiesel*



Biodiesel Emissions

EPA recently reported an analysis of all biodiesel emissions data:

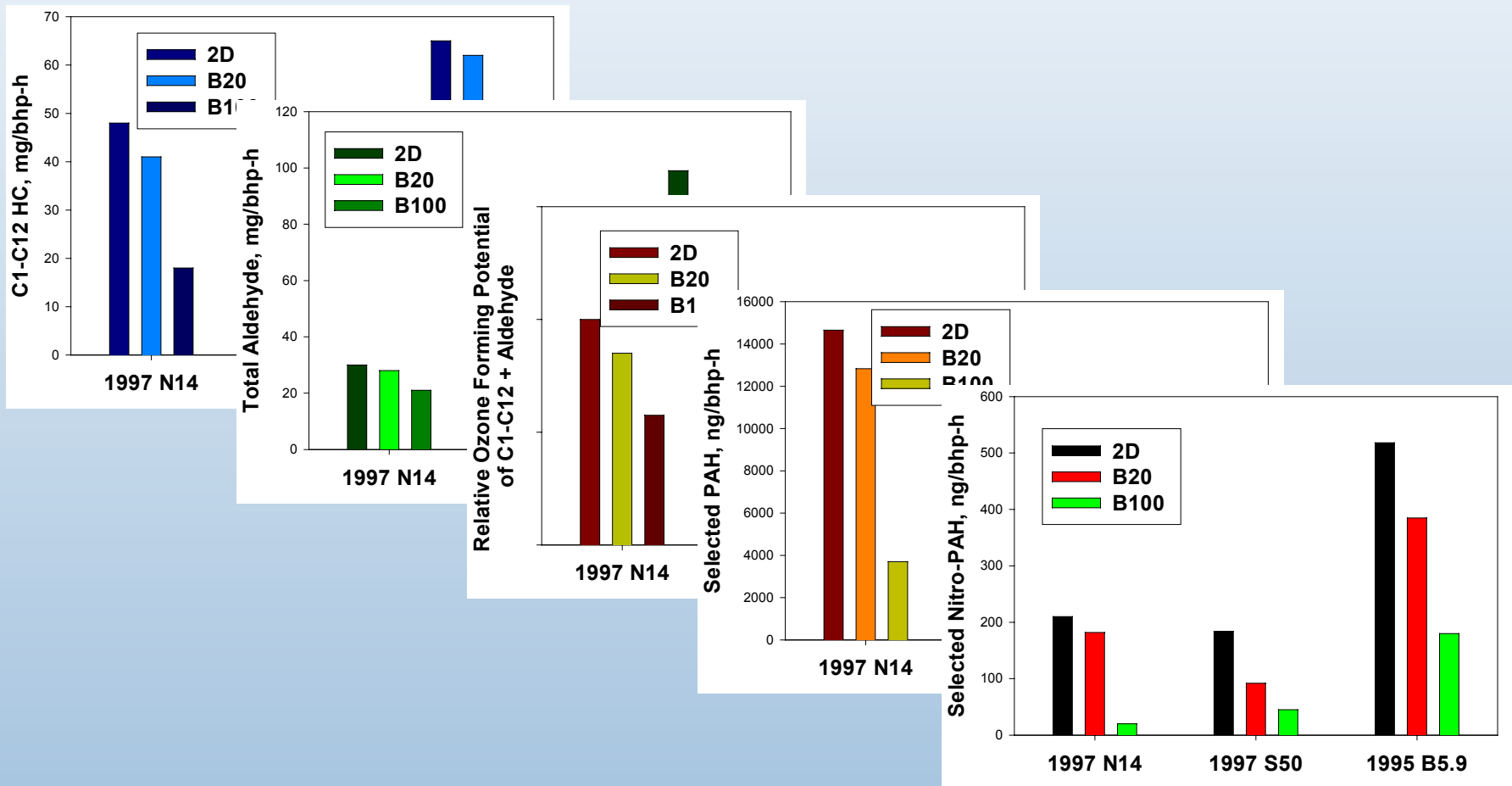
- PM, HC and CO reduction
- NO_x increase, 2-4% for B20, insignificant for B5
- No data for engines more recent than 1997



Data from EPA420-P-02-001, heavy-duty engines

Toxics Emissions

Generally lower for biodiesel:

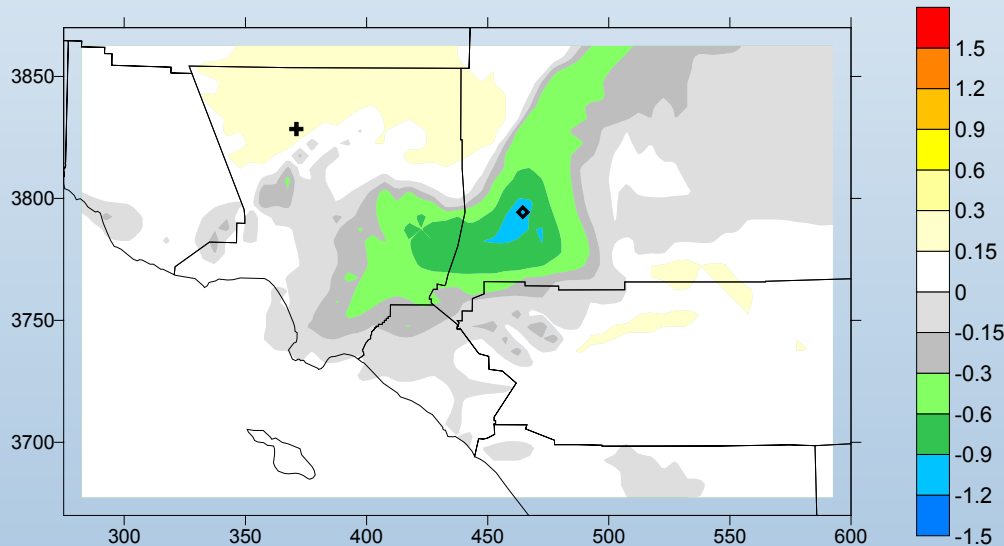


Data from Sharp, et al., SAE 2000-01-1968

Air Quality Modeling for Biodiesel

- Modeled 100% market penetration of B20 on air quality.
- NO_x from B20 use has no negative air quality impact (changes in ozone less than 1 ppb).
- NO_x inventory will increase for B20
- PM emission reduction has no positive impact.

✚ max = 0.26 PPB
✦ min = -0.98 PPB



Difference in Daily Max 1-Hour Ozone (ppb)
August 07, 1997
NREL Biodiesel -- 100% Penetration B20 Biodiesel minus Base

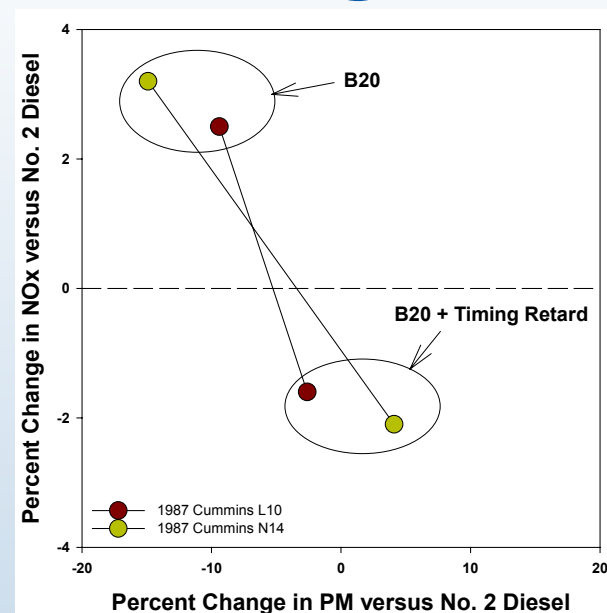


NO_x Reduction Strategies

Injection timing retard:

- Can eliminate NO_x increase for pre-1998 engines
- Reduces or eliminates PM benefit
- Can reduce fuel economy
- Requires engine certified on and dedicated to biodiesel

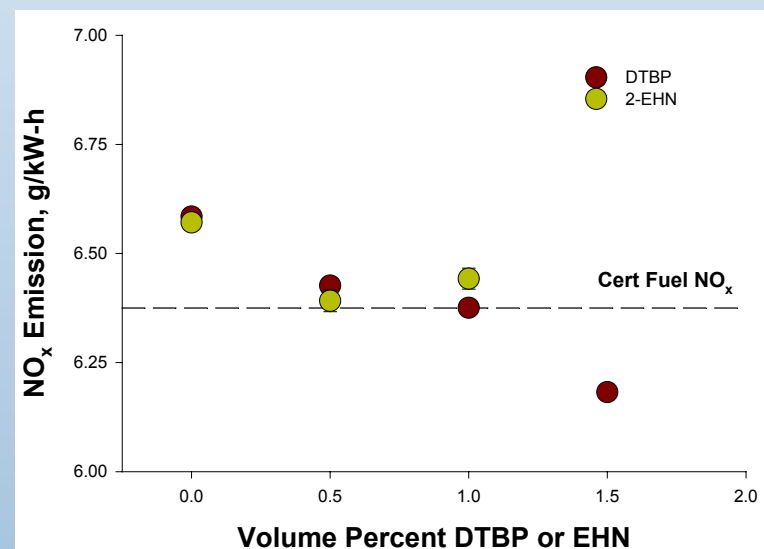
Graboski & McCormick, Progress in Energy and Combustion Science, 24 125 (1998).



Cetane increasing additives:

- Both EHN and DTBP effective for soy B20
- No change in PM emissions or fuel economy

McCormick, et al., SAE Tech. Pap. No. 2002-01-1658



Summary

- Truly renewable petroleum displacement fuel-*most important benefit*
- Reduced life cycle emissions of CO₂
- Causes emissions of HC, CO, PM and toxic compounds to go down
- Can slightly increase NO_x emissions and inventory

Thank You!

